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COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Report on the
1962
SUMMER INSTITUTE
IN SPACE PHYSICS

SPONSORED BY THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

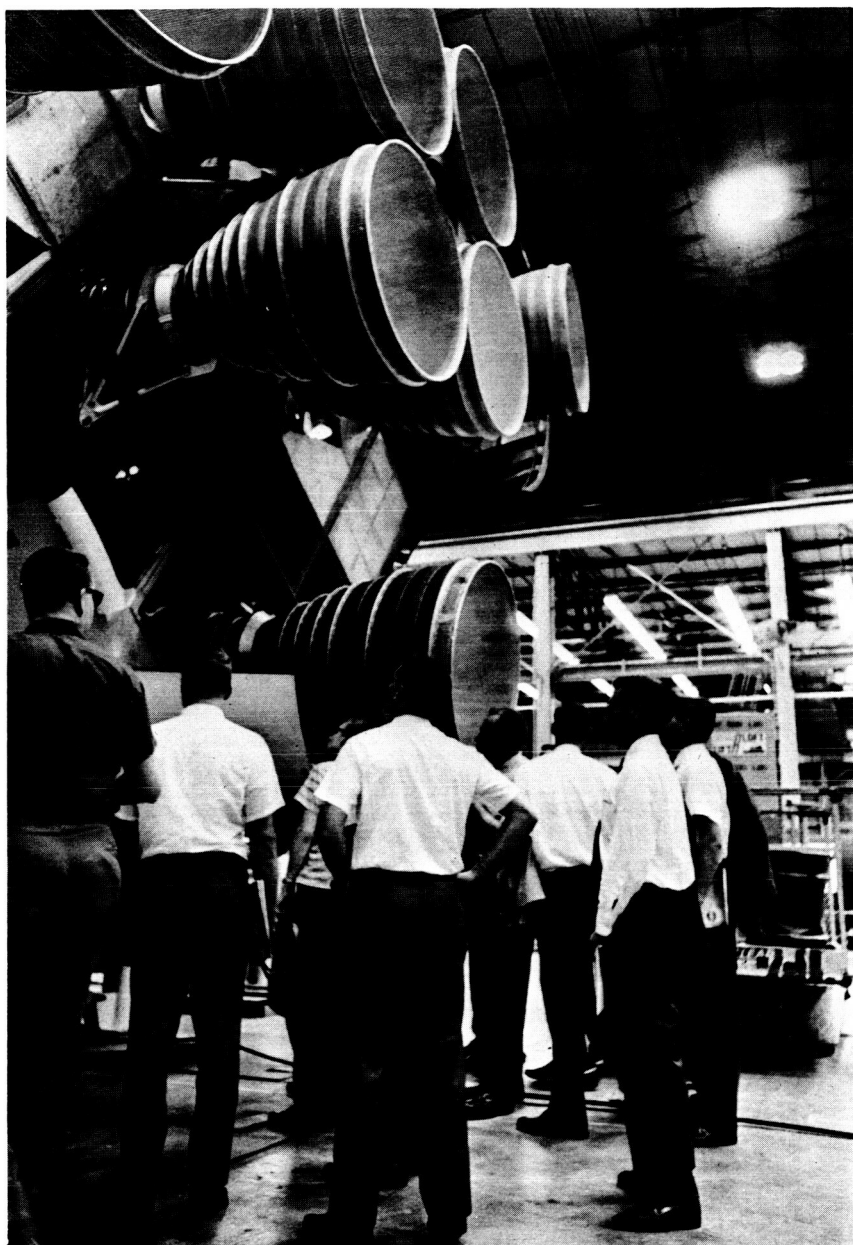
Report on the

1962

**SUMMER INSTITUTE
IN SPACE PHYSICS**

**HELD AT COLUMBIA UNIVERSITY
JULY 2—AUGUST 10, 1962**

**SPONSORED BY THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**



Students and staff of the Summer Institute inspect a Saturn launch vehicle at the Marshall Space Flight Center, Huntsville, Alabama.

The *Summer Institute in Space Physics* was organized as a part of the regular Summer Session of Columbia University during July and August of 1962, under the sponsorship and with the financial support of the National Aeronautics and Space Administration. The *Institute* was directed by Dr. Robert Jastrow, Adjunct Professor of Geology and Director of the Institute for Space Studies. The participants in the program included fifty-eight students from colleges and universities in the United States, eighteen European students, and four representatives of NASA centers.

The principal activity of the *Summer Institute* was a course of lectures in which physics, astronomy, and the earth sciences were synthesized into a description of the areas of physical science which play an important role in space research. The lectures dealt with certain basic aspects of theoretical physics and their applications to the central problems of astronomy and the earth sciences.

Dr. Jastrow gave the greater part of the lectures. He was assisted in the conduct of the afternoon problem and recitation sections by a staff of seven instructors. Guest lectures were given by Professor J. E. Nafe, Chairman of the Columbia Geology Department, on the internal structure of the planets; Professor Dirk Brouwer of Yale University, on the elements of celestial mechanics; and Professors Hubert Reeves of the University of Montreal and H. Y. Chiu of the Institute for Space Studies on nucleosynthesis.

The last week of the session was occupied by a field trip to NASA facilities at Huntsville, Cape Canaveral, and Greenbelt, during which the participants gained an acquaintance with some of the technical and experimental realities of the space program. The staff presentations and tour of facilities at Huntsville were particularly valuable.

The combination of daily lectures, afternoon problem sections, and evening preparation constituted a rigorous schedule for everyone involved. However, reports indicated that it was a highly rewarding experience for both students and staff.

Students and professors have written to indicate the strong impact which the *Summer Institute* had on the group in directing its attention to fundamental problems in astrophysics and the earth sciences, with which the students were for the most part entirely unacquainted before they had attended this course.

A letter has also been received from Professor Auger, Executive Secretary of the European Preparatory Commission Space Research Organization (COPERS), commenting on the favorable reactions of the European participants.

It appears that the *Summer Institute* was a successful experiment. From the viewpoint of the University, it brought to the Summer Session the stimulus of a talented group of students, and a course of lectures on a subject not usually presented in the Summer Session. From the viewpoint of NASA, the program directed the attention of gifted science students to the basic problems of space physics and helped to prepare them for potential careers in space research.

* * * *

Report on the 1962 Summer Institute

The activities of the University in conducting the 1962 *Summer Institute* included the distribution of announcements, processing of applications, selection of participants, appointment of the staff, conduct of lectures, problem sessions and examinations, and arrangements for the concluding field trip.

The following sections contain reports on activities in each of these areas.

ANNOUNCEMENT OF THE PROGRAM

Copies of the program announcements are supplements to this report (*See A and B*). The original announcement was mailed to the Secretaries of the universities and colleges on the general mailing list of the University, as well as to the Departments of Astronomy, Geology, Mathematics, and Physics in these universities and colleges.

LEVEL OF APPLICANTS

The announcement restricted applications to students with "a background equivalent to three years of college training in mathematics or the physical sciences." It was intended that this restriction would limit the applicants to those entering the senior year of college.

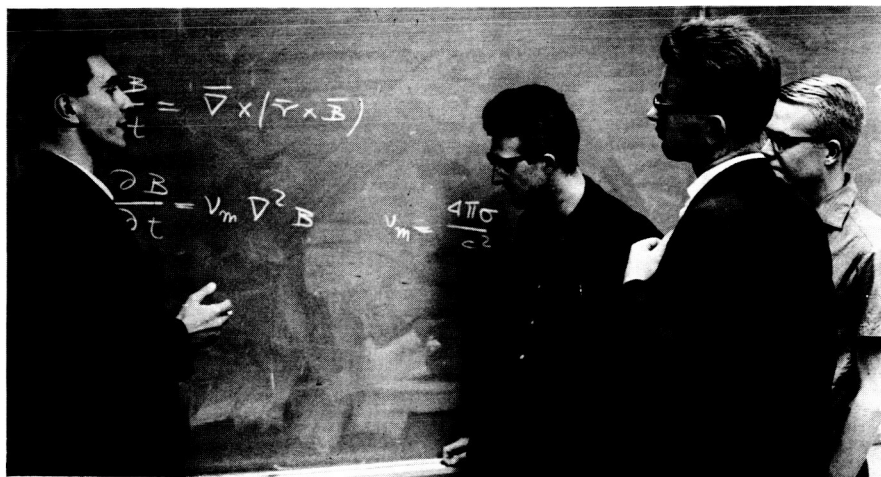
The first response to the announcement included a substantial fraction of applications from students completing their senior year or already in graduate school. In addition, the volume of the response was much greater than expected, in the light of the short interval of three weeks between the issuance of the announcement and the deadline for receipt of applications.

For these reasons, authorization was requested and received from the NASA for extension of the original program by ten students, and for the admission of students in the senior year or in graduate school. A supplementary announcement describing the extended program was then distributed.

SELECTION OF PARTICIPANTS

A total of 363 applications was received. The applications were given a preliminary evaluation by the University Admissions Office. The final selection was carried out by a panel drawn from the faculty of the University and the research staff of the Institute for Space Studies, with the following membership: Dr. Albert Arking, Dr. H. Y. Chiu, Dr. Jackson Herring, Dr. A. G. W. Cameron, and Dr. Patrick Thaddeus of the Institute; and Professors M. Schwartz and G. Feinberg from the Columbia Physics Department.

The panel selected 58 students from universities in the United States. *Supplement C* lists those selected, tabulated by state of origin, university and year in college.



Four European students work out a problem relating to the interplanetary plasma. (Left to right) Franco Occionero, Italy; Joseph Lemaire, Belgium; Kurt Marti, Switzerland, and Boudewijn Swanenburg, Netherlands.

EUROPEAN PARTICIPATION

At the suggestion of the NASA Office of International Programs, the program was extended to European students nominated by COPERS. The arrangements with COPERS were handled by the NASA Office of International Programs, with a final review of the European candidates by Dr. Jastrow. COPERS paid the expenses of the European participants up to the point of debarkation in New York. The remaining expenses connected with their stay in this country and their participation in the *Summer Institute* were paid by Columbia under a supplementary grant from NASA. Eighteen students from the following ten countries participated under COPERS sponsorship: United Kingdom 5, Sweden 2, France 3, Netherlands 3, Italy 1, Austria 1, Switzerland 1, Belgium 1, Norway 1.

PARTICIPATION BY NASA CENTERS

With the approval of the University, the Institute for Space Studies also invited each of the NASA centers to send a limited number of scientists and engineers to participate in the *Summer Institute*. In response to this invitation, the Langley Center and the Marshall Center each sent two individuals.

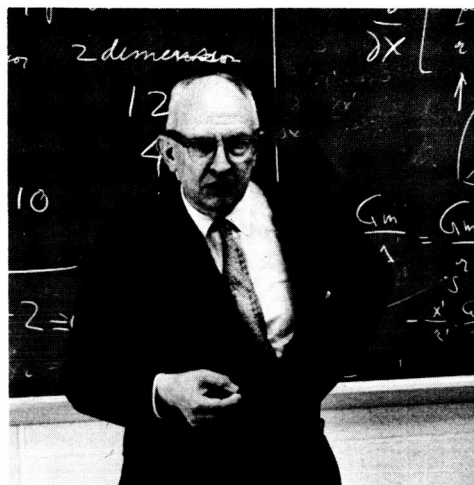
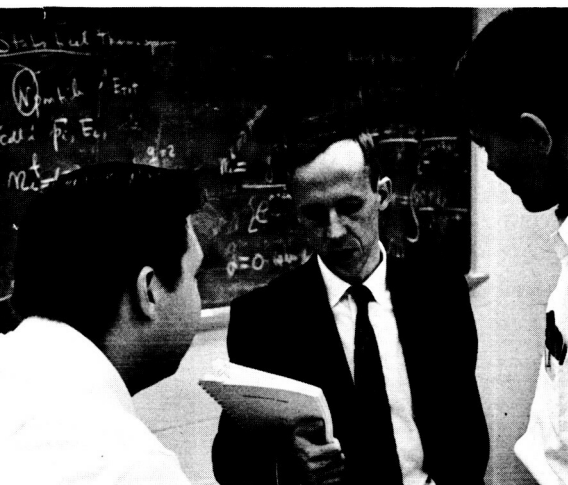
COMPOSITION OF THE CLASS

The supplements show the geographical distribution of the fifty-eight students from American universities, grouped by home state as well as the state in which the college or university was located. Forty-one of the students resided in states east of the Mississippi, and seventeen in states west of the Mississippi. The grouping according to schools shows the same distribution between East and West. (*See Supplement D*).

LECTURE COURSE IN SPACE PHYSICS

An outline of the course is contained in *Supplement E*. The lectures totalled 58 hours, divided into the following categories: I Atmospheric Physics, II Astrophysics, and III The Physics of Space Flight.

Professor Jastrow gave 44 lecture hours. In addition, the following guest lectures were contributed: Physics of Planetary Interiors (2) by



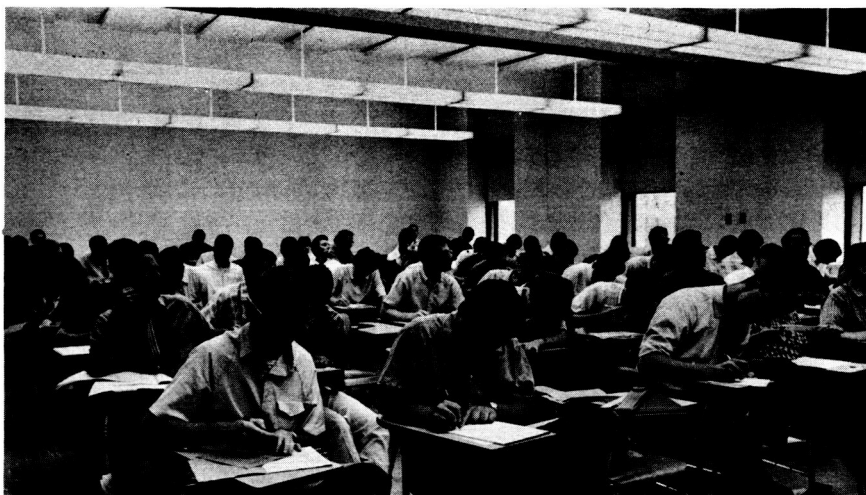
LEFT: Professor Hubert Reeves of the University of Montreal and a member of the Summer Institute staff, discusses a problem with students, Harold T. Larson (left) and Richard H. Ault. RIGHT: Professor Dirk Brouwer, Director of the Yale University Observatory, delivers a lecture on celestial mechanics.

Professor J. E. Nafe; Introduction to Celestial Mechanics by Professor Dirk Brouwer; Advanced Stages of Nucleosynthesis by Dr. H. Y. Chiu and Professor Hubert Reeves; Review of Chemical Propulsion Problems by Dr. Wernher von Braun; Advanced Propulsion Methods by Dr. Ernst Stuhlinger; Principles of Guidance and Control by Professor Walter Haeussermann.

The distribution of the lecture hours among these topics was as follows: Atmospheric Physics – 30 hours; Planetary Interiors – 4 hours; Astrophysics – 16 hours; Physics of Space Flight – 8 hours.

The students were given a written examination in atmospheric physics at the end of the third week. A second examination was given on astro-

Final examination.





Dr. Jastrow outlines a problem to a group of students in the afternoon discussion session.

physics and the elements of plasma physics at the end of the fifth week, just prior to departure on the field trip. The students were required to meet all course requirements before they were permitted to take the field trip.

The schedule of lectures consisted of two hours daily from Monday through Friday, plus two Saturday classes. Afternoon sections of two hours each were held twice weekly for discussion and problem review. Four sets of problems were distributed, and the students' answers were graded.

The supplements to this report include the examinations and the problem sets. (*Supplements F-K*)

FIELD TRIP

The field trip occupied the last week of the six week course. The trip began on Sunday, August 5, 1962, when the participants departed by a chartered National Airlines DC-7B plane for the NASA Marshall Space Flight Center at Huntsville, Alabama. The schedule at Huntsville was divided as follows: the morning of Monday, August 6, lecture on chemical propulsion and the Saturn rocket by Dr. von Braun; afternoon of August 6, lecture on advanced propulsion by Dr. Stuhlinger, and a

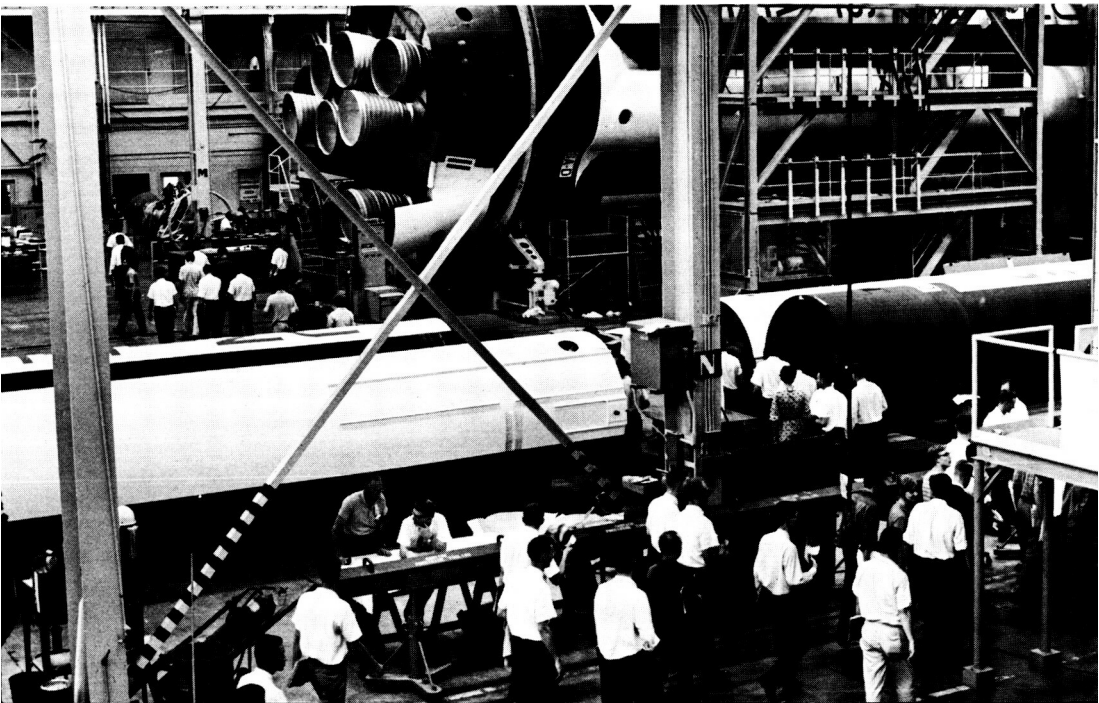


James Walker (right), of the Summer Institute staff, chats with Brian G. Taylor en route to Huntsville aboard a charter flight.

tour of Saturn shops and facilities; the morning of August 7, lecture by Dr. Haeussermann on guidance and control, tour of the Guidance and Control Laboratories, and a trip to the test stands to witness a static firing of an H-1 engine.

On the afternoon of August 7 the group departed Huntsville for Cape Canaveral. On August 8 the NASA representatives took the group on a

Inspection of the assembly shop for the Saturn launch vehicle at the Marshall Space Flight Center.





LEFT: Students and instructors await the static firing of an H-1 engine at the Marshall Space Flight Center. Foreground, left to right: John L. Roeder, Arlan W. Mantz, Kevin Cahill and Stuart H. Kellington. Rear, left to right: Dr. Patrick Thaddeus, of the Summer Institute staff, Joseph Lemaire, Dr. William Hoffman, of the Summer Institute staff, Lawrence H. Domash, Dr. Hong Yee Chiu, of the Summer Institute staff and Donald Chi.

BELOW: Coy Bryant, Rocketdyne engineer at Marshall, explains the mechanism of an H-1 engine to Miss Gun Ohlsson and Dr. Hoffman.





Summer Institute students and staff assembled at Launch Operations Center, Cape Canaveral, in front of the gantry surrounding the Atlas-Agena B rocket that subsequently launched the Mariner II probe to Venus.

Students and staff listen to an explanation of Mercury Control Center procedures at Cape Canaveral.





Dr. Jastrow explains the plasma probe mounted aboard the Explorer VIII satellite to (left to right): William G. Mankin, Ron G. Crawford, Clive R. Negus, Arlan W. Mantz, Charles D. Chenoweth and Richard H. Ault, during a tour of the Goddard Space Flight Center.

tour of the Saturn launch pad, the Mercury building, and the Mercury control room. They departed Cape Canaveral for Washington that afternoon. On the morning of August 9, chartered buses took the participants to the Goddard Space Flight Center in Greenbelt, Maryland, where they were divided into three groups for a tour of Goddard experimental satellite models, test facilities, and Mercury and orbit determination control rooms.

Many students commented afterwards that they found the field trip to be extremely informative, and found it particularly effective to have had a combination of the fundamental theory in the formal lectures, and the experimental and technical realities as explained in the field trip.

Participants departed Washington for New York City that afternoon and arrived in New York at 6:00 p.m. on Thursday.

The program of the *Summer Institute* concluded on Friday August 10, with a lecture on satellite experiments.

Supplement A

COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK

SUMMER INSTITUTE IN SPACE PHYSICS

July 2 - August 10, 1962

UNDERGRADUATE SCHOLARSHIPS

Columbia University announces a program of undergraduate scholarships for participants in the Summer Institute in Space Physics. The Institute will be conducted under the direction of Prof. Robert Jastrow from July 2 through August 10, 1962, as a part of the regular Summer Session of Columbia University. It will be arranged for a group of not more than 50 undergraduates majoring in mathematics or the physical sciences. Participating students will be selected by the Departments of Geology and Physics of Columbia University. Scholarships will be awarded on the basis of a national competition, and will include full tuition, a subsistence allowance, round-trip travel expenses to New York, and a field trip to national centers of space research.

THE PROGRAM OF THE INSTITUTE

The principal activity of the Institute will be a course of lectures on theoretical physics. The course description is as follows:

Introduction to Space Science.

Professor Jastrow, staff, and visiting lecturers. Lecture: daily, Monday through Friday 9 to 11 a.m. Discussion and problem sections: two 2-hour sessions weekly at hours to be arranged. Academic credit: 6 points.

1. Development of some of the fundamental concepts of physics, and their application to current problems of space research, including: stellar structure and evolution, planetary structure, and the physics of the atmosphere and the interplanetary medium.

The elements of radiative and convective transfer, nucleosynthesis, hydrodynamics, and plasma physics will be developed in this part of the course.

2. Four lectures on the principles of rocket propulsion, spacecraft construction, and space flight communications, to be delivered by Dr. Werner Von Braun and others active in the space flight program.

FIELD TRIP

A field trip to NASA Research Centers will be conducted in the concluding phase of the Institute program. This trip will include a visit to the Marshall Center in Huntsville, Alabama, for a tour of projects in propulsion, rocket and spacecraft guidance and control, and spacecraft development; and a visit to the Goddard Center in Greenbelt, Maryland, for an examination of experimental work in progress on scientific satellites.

SCHOLARSHIPS

Participants in the Institute program will receive scholarships covering the cost of tuition, a subsistence allowance of \$60 per week, and the expenses of round-trip travel from their point of origin in the United States to New York City. The scholarships will also include the cost of the field trip.

HOUSING

Assistance will be provided in finding quarters in the vicinity of Columbia. Dormitory accommodations will also be available.

REQUIREMENTS FOR ADMISSION

To be eligible for a scholarship the applicant must have a background equivalent to three years of college training in mathematics or the physical sciences. Mathematics through advanced calculus is essential. Junior-level courses in mechanics, electricity, and modern physics are desirable but not required. Introductory courses in astronomy, chemistry, geophysics, or geology will also be helpful. The awarding of scholarships will be based on evidence of superior intellectual attainments rather than the completion of a specific sequence of courses. The Institute program is intended for undergraduates entering the senior year, but students of less advanced standing may also be admitted if they possess the necessary background in mathematics and physics.

PROCEDURE FOR APPLICATION

Applications will be reviewed by a selection panel drawn from the Physics and Geology Departments of Columbia University. Letters of application should be submitted to

Director
Summer Institute in Space Physics
Columbia University
New York 27, New York

Letters must include: (1) home and school addresses; (2) a complete list of college courses and grades; (3) a one-page typewritten statement of the scientific goals and interests of the applicant. The applicant must also solicit letters of reference from three college professors who know his work well, at least two of whom must be in scientific fields. The letters of reference should be sent direct to the Director of the Summer Institute in Space Physics at Columbia University.

The deadline for receipt of applications is March 9, 1962. Awards will be announced on March 20, 1962.

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

**SUMMER INSTITUTE
IN SPACE PHYSICS**

**SUPPLEMENTARY ANNOUNCEMENT
SENIOR AND GRADUATE SCHOLARSHIPS**

The scholarship program of the Summer Institute in Space Physics has been extended to include students who are currently completing their senior year or are in their first year of graduate studies. Twenty-five scholarships will be available to college seniors and graduate students through the extended program.

The scholarships will cover the cost of tuition for a course of lectures on space science, to be given by Professor Jastrow, staff, and visiting lecturers, in the Summer Session of Columbia University. The course will include a daily lecture, 9-11 a.m., Monday through Friday, plus 4 hours of discussion and problem review weekly. It will extend from JULY 2 THROUGH AUGUST 10, and carry academic credit of 6 points in the Summer Session. This course will apply some of the fundamental concepts of physics to current problems of space research, including: stellar structure and evolution, planetary structure, and the physics of the atmosphere and the interplanetary medium. The elements of radiative and convective transfer, nucleosynthesis, hydrodynamics, and plasma physics will be developed.

A special seminar in advanced problems will be arranged for qualified students.

Scholarships will also include the following:

- (1) A subsistence allowance of \$60 per week during the six-week summer session.
- (2) Round-trip travel expenses to New York City from the point of origin of the student in the United States.
- (3) The cost of a field trip to the NASA Marshall Center at Huntsville, Alabama, for a tour of projects in propulsion, rocket and spacecraft guidance and control, and spacecraft development; and a visit to the NASA Goddard Center in Greenbelt, Maryland, for an examination of experimental work in progress on scientific satellites.

HOUSING

Accommodations will be provided in University dormitories.

REQUIREMENTS

To be eligible for a senior or graduate scholarship the applicant must have a background equivalent to four years of college training in mathematics or the physical sciences.

PROCEDURE FOR APPLICATION

Applications will be reviewed by a selection panel drawn from the Physics and Geology Departments of Columbia University. The application should be submitted in the form of a letter to Director, Summer Institute in Space Physics, Columbia University, New York 27, N. Y.

The letter of application must include: (1) home and school addresses; (2) a complete list of college courses and grades; (3) a one-page typewritten statement of the scientific goals and interests of the applicant. The applicant must also solicit letters of reference from three college professors who know his work well, at least two of whom must be in scientific fields. The letters of reference should be sent direct to the Director of the Summer Institute in Space Physics of Columbia University.

The deadline for receipt of senior and graduate applications is March 20, 1962. Awards will be announced on or before March 27, 1962.

SUPPLEMENT C

PARTICIPANTS BY STATE OF ORIGIN

ARIZONA

Robert Pfeffer, Tucson
Graduate Student, Trinity University

CALIFORNIA

Henry Abarbanel, Beverly Hills
Junior, California Inst. of Technology

Juri Eenmaa, Los Angeles
Senior, University of Southern California

Robert Golden, Berkeley
Senior, University of California

Albert Ito, Fresno
Junior, Fresno State College

Harold T. Larson, Los Angeles
Junior, Los Angeles State College

Peter Lee, San Luis Obispo
Junior, California State Polytechnical Coll.

Dennis Silverman, Los Angeles
Junior, U. of California at Los Angeles

Roger K. Ulrich, El Cerrito
Junior, University of California

CONNECTICUT

Franklin Cheung, New Haven
Senior, Yale University

Robert Melville, New Haven
Graduate Student, Yale University

Jane Rea, West Hartford
Junior, Mount Holyoke College

FLORIDA

Richard H. Ault, Miami
Junior, University of Miami

Juan H. Cheng, Tallahassee
Graduate Student, Florida State University

Gilberto Perez-Guillermo, Miami
Sophomore, M.I.T.

ILLINOIS

Charles D. Chenoweth, Belleville
Junior, University of Illinois

Bruce A. Peterson, Rockford
Junior, M.I.T.

IOWA

Eduardo Macagno, Iowa City
Sophomore, University of Iowa

Charles P. Martens, Charles City
Senior, University of Michigan

LOUISIANA

Edmund H. Christy, Jr., New Orleans
Graduate Student, Tulane University

Carl Smith, Paradis
Junior, Loyola of the South

MASSACHUSETTS

Wyland L. Blanchard, Amherst
Junior, Amherst College

Roger J. Sullivan, North Chelmsford
Senior, M.I.T.

MICHIGAN

Ronald A. Andrews, Pontiac
Senior, Wayne State University

Raymond T. Hoobler, Ann Arbor
Senior, Oberlin College

Kenneth Hunter, Muskegon
Sophomore, Kalamazoo College

Perry Smith, Clarkston
Junior, Albion College

MISSOURI

John L. Roeder, Webster Groves
Senior, Washington University

MONTANA

Robert Dasenbrock, Missoula
Junior, Montana State College

NEW JERSEY

C. James Elliott, Ridgewood
Sophomore, Lafayette College

NEW YORK

Uri Bernstein, Kew Gardens
Junior, M.I.T.

Participants (continued)

James Blummer, Scarsdale
Junior, Yale University

Kevin Cahill, New York City
Junior, Notre Dame

Robert Edelson, Brooklyn
Junior, M.I.T.

Richard Goodman, Brooklyn
Junior, Harvard University

Adele Goodstein, Brooklyn
Senior, Brooklyn College

Kenneth Klein, Brooklyn
Junior, Brooklyn College

George A. McGinn, Yonkers
Senior, Manhattan College

John W. Palchefsky, Jr., Maspeth
Junior, Polytechnic Inst. of Brooklyn

George Patsakos, Brooklyn
Senior, Columbia University

Harvey Picker, Kew Gardens
Junior, M.I.T.

Richard Rasala, Brooklyn
Junior, Columbia University

Stephen Rock, Brooklyn
Sophomore, Columbia University

Eric Roffman, Little Neck
Graduate Student, Brandeis University

Jeffrey D. Rosendhal, Hollis
Senior, Williams College

Robert A. Schwartz, Brooklyn
Senior, Yale University

Floyd W. Stecker, New York City
Junior, M.I.T.

George M. Weinberger, Brooklyn
Junior, Cornell University

Norman J. Weiss, West Hempstead
Junior, Harvard University

OKLAHOMA

Earl E. Lafon, Oklahoma City
Senior, University of Oklahoma

PENNSYLVANIA

Donald Chi, Pittsburgh
Senior, Willamette University

Arlan W. Mantz, Slatington
Senior, Catawba College

SOUTH CAROLINA

Judith Holbrook, Spartanburg
Senior, Converse College

TENNESSEE

Herman T. Fortune, Ramer
Junior, Memphis State University

William G. Mankin, Memphis
Senior, Southwestern at Memphis

TEXAS

Lawrence H. Domash, Houston
Junior, University of Chicago

WASHINGTON, D.C.

Patricia Norgorden, Washington, D.C.
Sophomore, Pomona College

WEST VIRGINIA

Joel L. Groves, Canvas
West Virginia University

SUPPLEMENT D

Number of Students whose state
of residence is EAST of the
Mississippi

Connecticut	3
Florida	3
Illinois	2
Massachusetts	2
Michigan	4
New Jersey	1
New York	19
Pennsylvania	2
South Carolina	1
Tennessee	2
Washington, D. C.	1
West Virginia	1

Number of Students whose state
of residence is WEST of the
Mississippi

Arizona	1
California	8
Iowa	2
Louisiana	2
Missouri	1
Montana	1
Oklahoma	1
Texas	1

* * *

Number of Students whose school
state is EAST of the Mississippi

Connecticut	4
Florida	2
Illinois	2
Indiana	1
Massachusetts	13
Michigan	4
New York	8
North Carolina	1
Ohio	1
Pennsylvania	1
South Carolina	1
Tennessee	2
West Virginia	1

Number of Students whose school
state is WEST of the Mississippi

California	9
Iowa	1
Louisiana	2
Missouri	1
Montana	1
Oklahoma	1
Oregon	1
Texas	1

SUPPLEMENT E

OUTLINE OF LECTURE COURSE IN SPACE PHYSICS

I. Atmospheric Physics

Origin and evolution of planetary atmospheres

Escape of atmospheric gases

Survey of atmospheric structure

Radiative transport

The ozone layer

The ionosphere

Thermal structure of the upper atmosphere

Plasma physics and application to the magnetosphere

II. Astrophysics

Equations of stellar structure

Nucleosynthesis

Approximate solutions to the equations of stellar structure

Comparison with the properties of main sequence stars

The red giants

Advanced stages of nucleosynthesis

Supernova explosions

Properties of matter at high temperatures and pressures; white dwarfs

Role of neutrinos in stellar evolution

III. The Physics of Space Flight

Elements of satellite orbit theory

Basic physics of rocketry and propulsion

Principles of guidance and control